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A preliminary survey of the ant fauna of the Darling Plateau and Swan Coastal Plain near Perth, Western Australia

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Abstract

Sixty-eight ant species in 22 genera were collected by pitfall traps and hand sampling made along 2 transects, one north and one south of Perth, running across the Coastal Plain and on to the Darling Plateau. Six vegetation associations were represented along each transect. There were no trends in species richness, diversity or evenness across the transects although overall species composition differed between certain vegetation associations. These differences are discussed in terms of soil type and vegetation association and the results are compared with those from a similar study in the Queensland sub-tropics.

Introduction

There are well over 1 500 species of ants in Australia (Brown and Taylor 1970), and many of them are of significant ecological or economic importance. In the southwest of Western Australia, for instance, species of *Pheidole* and *Rhytidoponera* prey on larvae of the economically significant jarrah leaf miner, *Perthida glyphopa* during spring when larvae fall to the ground and burrow (Z. Mazanec 1975 pers. comm.) In addition, *Rhytidoponera inornata* and *Melophorus* sp. 1 (ANIC) are significant agents assisting the germination of *Acacia* spp. seeds (Shea *et. al*, 1979. This is of particular importance in view of the interest in promoting a leguminous understorey in the Western Australian jarrah (*Eucalyptus marginata*) forest to suppress dieback disease caused by the pathogenic fungus *Phytophthora cinnamomi* (Anon. 1978).

The work described in this paper is a preliminary survey of the ant fauna found in areas of differing soil and vegetation association close to Perth, Western Australia. One aim of the study is to relate ant species distribution and overall community composition to soil and vegetation type. The information gained should be of value in forest management and also, since the survey is in an area of continuing high human impact, should contribute base-line data from which environmental change can be detected (O'Brian 1975).

Areas studied

The area immediately adjacent to Perth consists of a flat Coastal Plain bounded to the east by the Darling Scarp (Fig. 1) beyond which lies the Darling Plateau. The vegetation of this region was first mapped by Speck (1952) (summarised in Seddon 1972) although a more refined vegetation classification and map has recently been produced by Heddle *et al.* (1980). The soil types and major landforms have been mapped in Anon (1980). Speck's (1952) map was originally used for selecting our study plots although the vegetation associations described here are those of Heddle *et al.* (1980).

The sandy Coastal Plain may be broadly divided into a number of landform units which run more or less parallel to the coastline. These are the Quindalup Dune System which occurs adjacent to the coast, and the Cottesloe, Karrakatta, Bassendean and Southern River Dune Systems. The Darling Scarp soils are shallow red and yellow earths with considerable rock outcrop and the Darling Plateau has lateritic soils.

The area has a mediterranean climate. The 800 mm isohyet runs close to, and parallel with, the coast near Perth while the 1 000 mm isohyet corresponds closely with the top of the scarp in this region.

Two east-west transects were established respectively north and south of Perth city for surveying the ant fauna. The north transect ran from Mullaloo Beach to Old Toodyay Road on the Darling Plateau and the south transect extended from Cape Peron to Armadale (Fig. 1). Six survey plots were established along each transect at sites representing six representative vegetation associations (Fig. 1). Since much of the Coastal Plain has been cleared care was taken to select areas representative of the original vegetation.

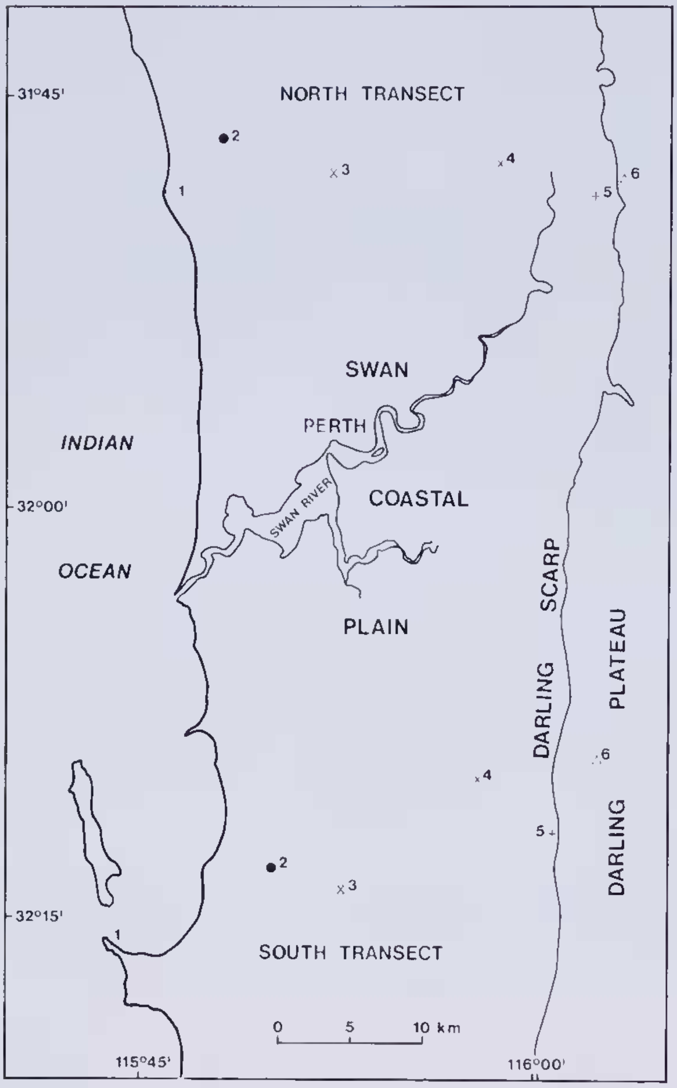

Figure 1.—Distribution of the ant survey study plots. ○, coastal closed-scrub; ●, tuart-jarrah-marri open-forest; ⊗, jarrah-banksia tall-woodland; x, banksia-sheoak-prickly bark tall-woodland; +, wandoo-marri tall-woodland; △, jarrah-marri open-forest.

The plot numbers and their respective vegetation associations are given in the caption to Table 1. Plots 1N and 1S were both situated in closed-scrub of the Quindalup Dune System. Plots 2N and 2S occurred on the Cottesloe Dune System and were covered by an open-forest of tuart *(Eucalyptus gomphocephala)*, marri *(Eucalyptus calophylla)* and jarrah. Plots 3N and 3S respectively overlapped the Karrakatta and Bassendean Dune Systems; in both cases the vegetation was a tall-woodland of jarrah and *Banksia* spp. Plots 4N and 4S occurred on the Bassendean Dune System and were situated in tall-woodland of *Banksia* spp., sheoak *(Casuarina fraserana)* and prickly bark *(Eucalyptus todtiana)*. The Darling Scarp plots (5N and 5S) were situated in tall-woodland of wandoo *(Eucalyptus wandoo)* and marri while the Plateau plots (6N and 6S) were representative of jarrah-marri open-forest.

Methods

The ant survey

Plots of approximately 2.5 ha were selected in late February, 1979. Forty pitfall traps were then established in each plot in order to sample the range of principal ground habitats within the area. Traps consisted of 18 mm internal diameter Pyrex test tubes containing 10 ml of alcohol/glycerol (70/30 mix by volume) preservative. Traps were left in the ground for 7 days in early March to give a total of 280 trap-nights per plot. Hand collections were also undertaken during March for 1 man-hour in each plot during the daytime.

The hand collections and trap samples were sorted to species level. Where ants could not be assigned specific names they were coded with Australian National Insect Collection (ANIC) or Western Australian Institute of Technology (J.D.M.) code numbers. The taxonomy of many Australian ant genera is not well known. Some of the species names given in this paper apply only in a very broad sense and therefore identify what are often species complexes. Voucher specimens are retained at the Western Australian Institute of Technology.

Data analysis

The data were subjected to several analyses. Ant species richness in plots was derived by summing the total number of species obtained by both sampling methods. The diversity of ants was further investigated using Shannon's (Shannon and Weaver 1949) H' index. This was calculated by the following formula:

$$H' = \frac{N \log N - \sum_i n_i \log n_i}{N}$$

where N is the total number of individuals and n the number of individuals of each species to the ith species. This index is of only limited value for describing the diversity of ant faunas since it combines two factors: species richness and species evenness. However it is a useful method for calculating the latter, which is the degree of apportionment of the individuals amongst the species present in an area. Evenness was calculated by the following formula:

$$J' = \frac{H'}{\log S}$$

where S is the total species present.

Only pitfall trap data were used for calculating these two indices since hand collections did not contribute quantitative data.

The composition of the ant fauna in each plot was compared using principal components ordination analysis. The ordination technique first compares the species content of the samples using Orloci's (1966), Weighted Similarity Coefficient (W.S.C.).

$$W.S.C = \sum_{i=1}^{n} (x_{ij} - \bar{x}_i)(x_{ih} - \bar{x}_i)$$

where x_{ij}, x_{ih} are the species scores for samples j and h, $\bar{x}_i$ is the species score for the average stand and n is the number of samples. The samples are then arranged along axes, termed components, so that the samples with the least similar species content occur farthest apart. The first component represents the combination of variables with maximum variance, subsequent components represent

Table 1

Systematic list of ants obtained by hand collection (*) or by pitfall trapping at the twelve study sites in February-March, 1979. Numbers represent total individuals caught in forty pitfall traps.

Transect and plot number	Vegetation											
	Coastal closed-scrub		Tuart-jarrah-marri open-forest		Jarrah-banksia tall-woodland		Banksia-sheoak -prickly bark tall-woodland		Wandoo-marri tall-woodland		Jarrah-marri open-forest	
	N1	S1	N2	S2	N3	S3	N4	S4	N5	S5	N6	S6
MYRMECIINAE												
Myrmecia chasei	*							1*				
PONERINAE												
Brachyponera lutea			6	6	1*	1				1	1*	1*
Cerapachys sp. J.D.M. 203						1						
Rhytidoponera inornata	32		15	1	4	5	2	4		140*	3	26*
R. violacea	369	89	338*	127		333*	36	176*	142	137*	126*	172*
R. sp. J.D.M. 121	1			4								
MYRMICINAE												
Aphaenogaster sp. J.D.M. 224	1											
Cardiocondyla nuda	2	*		1				1				
Chelaner sp.						*				1*	2	
C. sp. J.D.M. 502									35*			
C. sp. J.D.M. 503						41						
Monomorium sp. 1 (ANIC)	1			15								
M. sp. 2 (ANIC)							32					
M. sp. 3 (ANIC)	8	14	14	25	15	24	6	14	14	7	17	6
M. sp. J.D.M. 100								5			2	
M. sp. J.D.M. 225			15	134*	9		1		4	1	20	1
Pheidole latigena	4		7	2		8		16*	19	*	1	6
Padomyrma sp. J.D.M. 365										*		
Tetramorium bicarinatum											2	
T. impressun				2						2		
T. sp. J.D.M. 347	4		1	5							2	
T. sp. J.D.M. 492	2											
T. sp. J.D.M. 493												1
Crematogaster sp. J.D.M. 33	5	18			80*	78	6			1		
C. sp. J.D.M. 42			2				1					
C. sp. J.D.M. 350	3	14*	*	18	16*	*					2	
Meranoplus sp. 12 (ANIC)			7		1	20	3			4		1
M. sp. J.D.M. 74	1		2	1		8	1	13	1		8	7
M. sp. J.D.M. 157	9	2	5	1	4							
M. sp. J.D.M. 422	15		3	6		1	4		39		11	7*
M. sp. J.D.M. 491							10					12
DOLICHODERINAE												
Diceratoclinea sp. J.D.M. 211			1*			*					*	
Tapinoma sp. J.D.M. 134				2		1						
Iridomyrmex agilis gp.sp. 21 (ANIC)	15*	42*	5*	31	*	2	44*	88*	1*	2	*	23*
I. confer gp.sp. J.D.M. 72						*		29*		39	18*	
I. glaber gp.sp. J.D.M. 83	1		*		*						1	
I. purpureus gp.sp. J.D.M. 47									121*	19		
I. sp. 19 (ANIC)					*						1*	1
I. sp. J.D.M. 9	58*	20*	9*	5*	3	5*	3*	205	21*	85*	3	68*
I. sp. J.D.M. 84				*				3				
I. sp. J.D.M. 217				17*							4*	
I. sp. J.D.M. 449			2				1					
I. sp. J.D.M. 507			20									
I. sp. J.D.M. 508				1			*		4	2		
I. sp. J.D.M. 509	1	1				1	1	16				
FORMICINAE												
Camponotus calcius gp.sp.J.D.M. 27			1		*		*	*				
C. sp. J.D.M. 25				1				3		2		
C. sp. J.D.M. 106					*							
C. sp. J.D.M. 199	17		45	63*		3	75	194*	79*	1	12	84*
C. sp. J.D.M. 213										1		
C. sp. J.D.M. 233							3	1			*	
C. sp. J.D.M. 229							12	2	1			
C. sp. J.D.M. 287									*			
C. sp. J.D.M. 490						1				*		
Polyrhachis sp. J.D.M. 118		1										
Melophorus sp. 1 (ANIC)	4	*		27	*	5*	4*	8*	4	19		14
M. sp. 3 (ANIC)	2			15	1	*	3	17	*		1	
M. sp. J.D.M. 77							1				1	
M. sp. J.D.M. 221		1*		2	1		14		1			
M. sp. J.D.M. 230		*				*	12	2	1			
M. sp. J.D.M. 500				2		2						
M. sp. J.D.M. 501	2											
Notoncus gilberti	4		10				3			13		
N. sp. J.D.M. 487				1								
Plagiolepidini(gen.indet.)sp.J.D.M. 489											1	
Stigmacros sp. J.D.M. 80										2		
S. sp. J.D.M. 188				1						1		
S. sp. J.D.M. 488		1										

combinations with decreasing variance. The components may then be identified with environmental factors since these contribute to the variation in species composition. The resulting ordination is therefore a useful tool for investigating the relative influence of different environmental factors on fauna composition. Computations were performed using species presence/abence data for each plot. Austin & Greig-Smith (1968) found this provided as much information as numerical data.

Results

The ant species collected by hand and pitfall trap are listed in Table 1. Presence/absence data are indicated for the hand collections although numbers per 280 trap-days are shown for the species taken by the pitfall traps. Species richness, diversity and evenness indices for each plot are given in Table 2. The total species richness for both transects of each vegetation association is also given.

The survey yielded 68 species from 22 genera. The numbers of species collected in each plot varied from 14 to 29 (Table 2). The total species richness for each vegetation association varied from 29 to 37. There were no trends in species richness values across either transect. This was also the case with the species diversity and evenness indices which respectively ranged between 0.619-1.038 and 0.459-0.752.

It should be noted that this was a preliminary survey so the species census was incomplete. For instance, more detailed surveys in tuart-jarrah-marri open-forest at Jandakot (32° 10′ S, 115° 50′ E) and at Reabold Hill, Perth (31° 57′ S, 115° 47′ E) have yielded 43 and 57 species respectively. Thus the present census may have underestimated the true species richness values by a factor of two.

Inspection of the data shown in Table 1 indicates a surprising degree of ubiquity amongst most species found during this survey. A number of species were infrequently collected so it is not possible to confidently describe their distribution pattern. However, of the remainder, a few showed clearly definable patterns. For instance, a number of otherwise common species were absent from the coastal closed-scrub (e.g. *Brachyponera lutea*, *Monomorium* sp. J.D.M. 225 and *Meranoplus* sp. 12 (ANIC). Certain other species were widespread but absent from the open-forest of the Darling Plateau (e.g. *Melophorus* sp. J.D.M. 230). Several other species appeared to be confined to particular belts of the Coastal Plain (e.g. *Camponotus* sp. J.D.M. 229) while in this study the small purple form (Halliday 1979) of the meat ant, *Iridomyrmex purpureus*, was confined to the exposed gravelly soils of the Darling Scarp.

The ordination graph of axes 1 vs 2, which respectively represented 15.6 and 14.1 per cent of the total variance, is shown in Fig. 2. It was not possible to interpret axis 3 so it is not shown here. The most obvious trend in the plot spacings was that from the open-forest of the Plaeau to the left of axis 2 to the coastal closed-scrub fauna on the right of this axis. The other open-forest and woodland plots were grouped together near the middle of axis 2 although the tuart-jarrah-marri open-forest plots were separated on the upper part of axis 1.

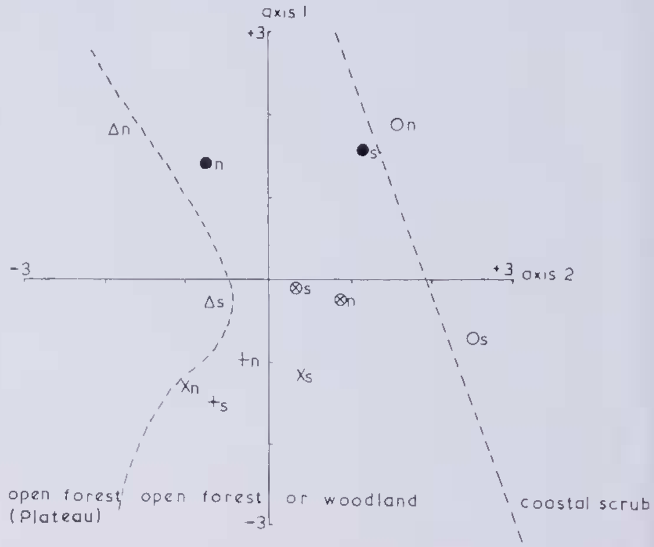

Figure 2.—Position of study plots in terms of ant species composition along axes 1 vs 2 of the principal components ordination diagram. Symbols as in Figure 1. n & s indicate north and south transect respectively.

Table 2

Ant species richness, diversity and evenness of the ant fauna sampled at the twelve study sites in February-March, 1979. The cumulative ant species richness for each vegetation association is also shown.

Transect and plot number	Vegetation: Coastal closed-scrub		Tuart-jarrah-marri open-forest		Jarrah-banksia tall-woodland		Banksia-sheoak -prickly bark tall-woodland		Wandoo-marri tall-woodland		Jarrah-marri open-forest	
	N1	S1	N2	S2	N3	S3	N4	S4	N5	S5	N6	S6
Species richness (S)	25	14	22	29	17	25	26	21	18	24	25	16
Cumulative species richness ...	29		37		32		33		32		29	
Species diversity (H¹)	0·634	0·716	0·635	0·996	0·619	0·621	1·038	0·855	0·842	0·819	0·813	0·799
Species evenness (J¹) ...	0·459	0·688	0·488	0·688	0·595	0·485	0·752	0·657	0·699	0·620	0·606	0·663

Discussion

The current study resembles that of Greenslade & Thompson (1981) which examined the ant faunas in different locations on sandy soils of the Cooloola sandmass and the sandstones of the Noosa River catchment on the Queensland coast. They found the ant fauna to differ within certain landforms, soil types and vegetation associations in terms of species composition, richness and community structure. These differences were explained by variation in soils, vegetation structure (e.g. its pattern, height, ground and canopy cover) and associated microclimates.

Our findings differ from those of Greenslade & Thompson (1981) in that, although species composition varied, there were no trends in ant species richness, diversity or evenness across either of the transects. On the Cooloola sandmass the areas of greater primary production, canopy height and cover were associated with a large increase in the richness of cryptic ant species which nest and forage within decaying logs, soil or litter. This trend in richness accounted for much of the ant community variation in the different study areas. In other habitats, such as vine forests, the trend of increased species richness under shade was reversed.

The microclimate is relatively harsh under the coastal closed-scrub, woodland and open-forest alike during the summer when this study was performed. Thus the opportunities for summer active cryptic species to abound under the more dense vegetation would, relatively speaking, be less in comparison with the Queensland study sites. This may not be the case for species which are more active during moister, more humid periods (Majer and Koch 1982) but the distribution of these species was not investigated. The absence of certain species under dense vegetation was attributed by Greenslade & Thompson (1981) to the relatively low temperatures experienced under such conditions. This effect is also unlikely to be as marked in the Western Australian sites studied since high ground temperatures were experienced under all densities of vegetation.

Greenslade & Thompson (in 1981) found three basic ant distribution patterns related to soil. These were:

1. only present on Cooloola sands,
2. widely distributed with respect to soils, and
3. only present on soils derived from Noosa River sandstones.

Our findings indicate a similar differentiation of distribution. Patterns we observed were:

1. absent from the Quindalup Dune System,
2. absent from the Darling Plateau,
3. confined to particular belts of the Coastal Plain or Darling Scarp, and
4. widely distributed with respect to soil.

The cumulative effect of these distribution patterns has produced the overall differentiation of ant communities on the ordination diagram (Figure 2). This investigation has not enabled us to clearly separate the influence of vegetation and soil although the distribution of plots on the ordination diagram (Figure 2) suggests that both factors play an important role in determining ant community composition.

Ecological information on individual species of ants is generally inadequate to discuss individual distribution patterns observed here. However a number of comments may be made on selected species.

Pheidole latigena and *Rhytidoponera violacea*, species known to prey on the Jarrah leaf miner, *P. glyphopa*, are distributed throughout the Coastal Plain and Darling Plateau (Table 1). *P. glyphopa*, is common on the Coastal Plain in this region but rare in the Darling Plateau east of Perth (Mazanec 1978). The ubiquity of the major ant predators in this region suggests that they cannot be the limiting factor in leaf miner distribution.

Melophorus sp. 1 (ANIC) and *R. inornata*, significant agents influencing *Acacia* spp. seed distribution and survival (Shea *et al.* 1979), are also widespread in most study plots. This suggests that the phenomenon of ants burying *Acacia* seed observed by Shea *et al.* (1979) in the forests of the Darling Plateau is also likely to occur on the Coastal Plain.

Apart from the humid parts of Australia, Australian ant communities are usually dominated by various species of *Iridomyrmex* which influence the remainder of the ants present (e.g. Greenslade 1976). The dominance of this genus was also the case in the plots we investigated although selective pitfall trapping of certain species (e.g. *R. violacea* (Table 1)) tends to obscure this phenomenon. Our investigation indicates a change in dominant species across the two transects studied. *Iridomyrmex agilis* and *Iridomyrmex* sp. J.D.M. 9 were the dominant species from the coastal closed-scrub through to the banksia-sheoak-prickly bark tall woodland. The small purple form of *I. purpureus* was dominant on the insolated gravelly slopes of the Darling Scarp although the shade regime was too heavy for it to occur in the more dense forest of the Plateau. A further species, a member of the *I. conifer* gp., reached dominant status in certain areas including the banksia-sheoak-prickly bark tall-woodland and to the east. This species was, until recently, common in other parts of the Coastal Plain but has declined in recent years (R. P. McMillan 1980, pers. comm.).

As ants are dominant members of many Australian invertebrate communities, the distribution of ant species probably affects the distribution of many other animal taxa. Thus the trends observed in our study may reflect those of other zoological components of the ecosystem.

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